APPLICATION NO. 10/806,016

INVENTION: Multi-scale code division frequency/wavelet multiple access

INVENTOR: Urbain Alfred von der Embse

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WHAT IS CLAIMED IS;

Claim 1. (currently amended) A method for implementation of multi-resolution complex Wavelet waveforms in the Fourier domain and orthogonal Wavelet division multiple access (OWDMA) filter banks, said method comprising:

deriving a single multi-resolution Wavelet implementation using design coordinates in the frequency domain to provide multi-resolution property for Wavelets at multiple scales and translations;

changing said Wavelet to a complex Wavelet in the Fourier frequency domain by incorporating a frequency translation as a Wavelet parameter in addition to existing scale (dilation) and translation (shift) parameters;

deriving said complex Wavelet with flexibility to meet filter design requirements;

constructing OWDMA filters and filter banks with said complex Wavelet channelization waveforms over frequency bands for simultaneous multi-resolution OWDMA filters at different scales and different frequencies and different symbol rates;

using said complex Wavelet to generate a multi-resolution mother Wavelet at dc using design coordinates in the frequency domain which enable the generation of a desired multi-resolution complex Wavelet using appropriate scale, frequency, and translation changes to the mother Wavelet; and

implementing said OWDMA filters in a communications transmitter and in a communications receiver for a communications link.

Claim 2. (currently amended) A method for implementation of multi-scale complex code division multiple access (MS-CDMA) encoding and decoding over multiple scales where each scale corresponds to an independent communications parameter, said method comprising:

generating independent subbands or groups of subbands over a frequency band;

generating a 2 scale MS-CDMA code and assigning the subbands over a frequency band into MS-CDMA groups, MS-CDMA encoding and spreading each user in each group such that each user is spread within each subband in the MS-CDMA group in a scale "0" encoding and spreading, each user in each group is spread over the subbands of the MS-CDMA group in a scale "1" encoding and spreading;

constructing a complex orthogonal 2-scale MS-CDMA code matrix as a Kronecker product (tensor product) of a subband complex orthogonal MS-CDMA code matrix for scale "0" encoding and spreading and a wideband complex orthogonal MS-CDMA code matrix for scale "1" encoding and spreading;

constructing a complex orthogonal N-scale MS-CDMA code matrix as a Kronecker product of orthogonal complex MS-CDMA code matrixes for each of the MS-CDMA scales "0", "1", . . , "N-1", with each scale assigned to an independent communications parameter, with each scale performing encoding and spreading of the users;

constructing an algebraic field factorization and scaling to convert a CDMA code matrix to a 2-scale CDMA code matrix by

generating a CDMA code with a code length equal to a product of a number of chips for a first scale "0" CDMA encoding having first code and chip indices used to encode data symbols within each subband, and a number of chips for a second scale "1" CDMA encoding having second code and

chip indices used to encode data symbols over the entire set of subbands,

forming a 2-scale CDMA code by assigning code and chip indices such that the 2-scale CDMA code and chip indices are the algebraic addition of the first scale "0" code and chip indices plus scaled second scale "1" code and chip indices, wherein said scaled indices are generated using a scale factor that comprises the number of indices in the first scale CDMA code,

wherein the steps of generating and forming further include encoding data symbols with the 2-scale CDMA code to generate encoded chips,

assigning each of the encoded chips to a subband in accordance with the second scale "1" CDMA code indices, assigning each encoded chip to a chip position within its assigned subband in accordance with the first scale "0" CDMA code indices,

and generalizing said implementation to scales "0", "1", . . . , "N-1" for an N-scale MS-CDMA code matrix with each scale assigned to an independent communications parameter, with each scale performing encoding and spreading of the users;

encoding and decoding MS-CDMA with fast algorithms;

controlling the power level the transmitted signal as a function of the frequency over the frequency band; and

implementing said N-scale MS-CDMA in a communications transmitter and in a communications receiver for a communications link.

Claim 3. (currently amended) A method for implementing MS-CDMA orthogonal frequency division multiple access (OFDMA) communications and for implementing MS-CDMA OWDMA communications, said method comprising:

assigning OFDMA or OWDMA users to channel groups and MS-CDMA encoding and spreading each set of users in these groups

with a 2 scale MS-CDMA code such that each user in a group is spread over all of the channels in a group in a scale "1" encoding and spreading, and is spread within each channel of a group in a scale "0" encoding and spreading;

constructing a MS-CDMA code matrix with a Kronecker product for encoding spreading at each of the scales, with each scale assigned to an independent communications parameter, with each scale performing encoding and spreading of the users, and with one or more scales assigned to OFDMA or OWDMA;

constructing a complex orthogonal multi-scale MS-CDMA code matrix for encoding spreading at each of the scales with a scaled algebraic field, with each scale assigned to an independent communications parameter, with each scale performing encoding and spreading of the users, and with one or more scales assigned to OFDMA or OWDMA;

encoding and decoding MS-CDMA,OWDMA, and OFDMA with fast algorithms; and

implementing said MS-CDMA OFDMA and MS-CDMA OWDMA filters in a communications transmitter and in a communications receiver for a communications link.